

## 3.

The Panama Canal as a Passageway for Fishes, with Lists and Remarks on the Fishes and Invertebrates Observed.<sup>1</sup>

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(Plates I &amp; II).

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## INTRODUCTION.

Whether the Panama Canal serves as a passageway for fishes, permitting at least some of the species of the opposite oceans to cross the Isthmus, has been a subject of conjecture ever since the Canal was built. It was questioned whether fish could successfully negotiate the locks, and if so whether any of them could endure the journey of about 40 miles through the fresh water between the locks at the opposite ends of the Canal. It is now possible to give limited information on these questions, and on the animal life in the locks in general, as a result of observations and collections made in 1935 and 1937, together with subsequent study.

This work was made possible largely through the financial aid given by Dr. Herbert C. Clark, Director of the Gorgas Memorial Laboratory, to whom the writer is greatly indebted also for numerous other courtesies. He is deeply appreciative also of the extensive help given by Dr. A. O. Foster of the Gorgas Memorial Laboratory, and in fact to the entire staff of that laboratory.

Officers of the Panama Canal, as well as more than a few employees, too,

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gave valuable aid. Among them are Col. C. S. Ridley, Governor; Col. Glen E. Edgerton, Engineer of Maintenance; Maj. W. D. Styer, Assistant Engineer of Maintenance; R. Z. Kirkpatrick, Chief of Surveys; E. D. Stillwell, Superintendent of Locks; H. M. Thomas and J. C. Myrick, Assistant Superintendents of Locks; Fred Whaler, Carl G. Brown, S. A. Venable, R. A. Cauthors and many others who cannot be named for want of space. Special mention must be made of the extensive aid and many courtesies extended by W. H. W. Komp, medical entomologist, U. S. Public Health Service; and J. B. Shropshire, malariologist, U. S. Army.

The writer is deeply grateful, also, to the several taxonomists, who identified various groups of animals collected. These specialists are named in the text in connection with the discussion of specimens identified by them. To these workers, who gave of their time and energy, the writer especially wishes to extend thanks.

One or more specimens of the species herein named, whether fish or invertebrates, have been or will be deposited in the U. S. National Museum.

Observations and collections were made in Gatun Locks, on the Atlantic side, during the early months of 1935, and in Pedro Miguel and Miraflores Locks, on the Pacific side, during the early part of 1937, when the writer was present to witness the dewatering of one side of each lock. The water is removed, partly by draining and partly by pumping, from the locks at intervals of about three years for the purpose of cleaning and generally overhauling them. Collections were made by others in the sides dewatered during the writer's absence. A particularly fine collection was secured in the east side of Miraflores Locks under the supervision of Dr. A. O. Foster of the Gorgas Memorial Laboratory. Representative specimens, as far as possible, were preserved from among the fishes and invertebrates stranded in the locks as the water was removed. Collections were made also in the fresh waters situated between the locks at the opposite ends of the Canal, as well as at several places on both shores of the Isthmus and some of the outlying islands.<sup>2</sup>

#### REMARKS CONCERNING THE CANAL AND LOCKS.

For the convenience of the reader who has not seen the Panama Canal, it may be stated that the general direction of the Canal is somewhat west of north and east of south, though traffic is designated as "north and south bound."

The Atlantic terminus of the Canal is entered from Limon Bay. A vessel sailing from the Atlantic to the Pacific, that is, southbound, proceeds at sea level as far as Gatun, a distance of 6 or 7 miles from Cristobal, the Atlantic port. There the Gatun Locks are reached. These locks, like those at the other end of the Canal, are double, permitting two-way traffic, the two channels of the locks commonly being designated the east and west side. The Gatun Locks consist of three equal flights whereby a southbound ship is lifted approximately 85 feet, to the level of Gatun Lake, which lies beyond the locks.

Gatun Lake is a large body of fresh water, having an area of about 196 square miles, created by damming the Chagres River. Though the deep water, that is, the course for vessels, is well marked with buoys and beacons in Gatun Lake, a definite channel or canal is not visible for a distance of somewhat more than 20 miles. Thereupon Culebra (or Gillard) Cut, is

<sup>2</sup> The study of the fresh water fishes and data pertaining to the fresh waters has been completed, and a report has been published, entitled, "A New Catalogue of the Fresh-Water Fishes of Panama" (See *Field Mus. Nat. Hist. Pub., Zool. Ser.*, xxii, 1938, pp. 217-359). The results of a study of the data and specimens secured in the locks are set forth herein. Much of the rather large collection of marine species taken along the outside shores of the Isthmus and the islands, however, remains for future study.

reached. This cut, through the continental divide, is about 9 miles long, and leads to Pedro Miguel Locks.

The Pedro Miguel Locks consist of a single flight, whereby a southbound vessel is lowered from the approximately 85-foot level of Gatun Lake to a level of about 53 feet of Miraflores Lake, which lies below these locks.

Miraflores Lake is a small body of fresh or brackish water (sometimes slightly brackish from lockage water when northbound traffic is heavy), scarcely 2 miles long in the direction of the Canal. A southbound vessel reaches the Miraflores Locks after crossing this small lake.

The Miraflores Locks consist of two equal flights whereby a southbound ship is lowered to sea level. The vessel now follows a rather definite channel (canal) to Balboa, the Pacific port of the Canal, a distance of about 4 miles, and then enters Panama Bay.

In passing a northbound ship through the Canal the processes described in the foregoing paragraphs are, of course, merely reversed. As already indicated the locks are double, making it possible to pass two vessels through them simultaneously either in the same or opposite directions.

#### THE LOCKS AS PHYSICAL BARRIERS.

The locks do not constitute serious physical barriers to fish, as explained at some length by the writer in a paper entitled, "The Tarpon in the Panama Canal" (*Scientific Monthly*, Vol. 44, Mar., 1937, pp. 245-246). Obviously fish may swim into the upper or lower chambers of the locks without meeting any obstruction whatever when the gates at the opposite ends of the locks are open. There they may remain more or less indefinitely, or they may follow the next ship through the locks. In the case of the Gatun Locks, with three flights, they could ascend from the lowest to the middle chamber with a southbound vessel, or descend to this chamber from the uppermost level with a northbound vessel. There they might remain for a time, or complete the transit through the locks with a single ship. It is understood, of course, that when the lock gates are open, as in passing a ship from one chamber to the next one, no physical obstruction remains to prevent the fish from following the vessel.

#### DIFFERENCE IN SALINITY A BARRIER.

The change in salinity from fresh to salt water or *vice versa*, depending upon the direction a fish may be pursuing, in going through Gatun or Miraflores Locks (this does not apply to Pedro Miguel Locks, as they are in fresh water), is a much more formidable barrier, to most fishes, than the locks themselves.

That many marine fish enter the locks and go through a part of the way, at least, is evident from the large number present at each dewatering. Several marine and brackish water species appear to live in the locks indefinite periods of time, and a few probably are permanent residents. It is to be noted, however, that strictly fresh water species seem to avoid the locks, as very few individuals or species were present even in the fresh water of the Pedro Miguel Locks, and in the nearly fresh water of the upper chamber of Gatun Locks. The abundance of fish in the middle and lowest chambers of Gatun Locks and both Chambers of Miraflores Locks suggests that food probably is plentiful and that conditions otherwise are agreeable to a comparatively large number of salt and brackish water species, as shown by the lists appended.

The temperatures and particularly the salinities, as already pointed out, profoundly affect the animal life in different parts of the Canal. The tables

and some of the other data offered were very kindly furnished by R. Z. Kirkpatrick, Chief of Surveys of the Panama Canal. The temperatures, given in Table I, are a summary of records covering the period from 1908 to 1936 inclusive for Balboa and Colon, and from November, 1918, to December, 1936, inclusive for Gatun Lake. The period of time covered by the records of salinity given in Table II, was not furnished.

The "Pacific Entrance (Inner Harbor)" and the "Atlantic Entrance (Inner Harbor)" temperatures, as well as the salinities, were taken respectively at the Balboa and Cristobal Docks.

On the Pacific side a cold water period occurs during the dry season. Concerning this Mr. Kirkpatrick said: "Cold water period is from February to April; it is caused by Antarctic colder water being welled-up over Panama Bay Bottom Shelf during these months." As understood by the writer, the brisk trade winds blowing across the Isthmus from the Atlantic to the Pacific have something to do with the up-welling of cold water in Panama Bay, as they tend to drive the warm surface water off shore.

Outside the inner harbor the water temperatures apparently drop considerably lower, as shown by some records kindly furnished by W. H. W. Komp, U. S. Public Health Service. Mr. Komp took the water temperatures with a pocket thermometer at Amador Beach during the dry seasons of 1934, 1935, 1936 and 1937. Each season, exclusive of 1937, the temperatures ranged downward into the sixties, the lowest occurring in 1934 when the water along the beach, between 4 and 5 o'clock in the afternoon, ranged in temperature from 60.5° to 63° F. from Feb. 11 to 16.

These low temperatures affect fishing profoundly in Panama Bay, as such important game fishes as the sailfish, marlin, and dolphin are missing during this season. On the other hand, the corbina (sea trout or weakfish) seem to become more numerous. The cold water probably causes the fish population to vary to some extent with the season also in Miraflores Locks.

Tides and lockage water have a direct bearing on salinity at both ends of the Canal. Mr. Kirkpatrick stated: "Tidal ranges on the Pacific side vary between an elevation of +11.0 and -10.5 feet, with a mean range of about 12.6 feet. . . . Tidal ranges on the Atlantic side do not exceed 24 inches." He stated furthermore, "Inner harbor salinities and densities are affected, of course, by the down-lockage of fresh water from Miraflores and Gatun Lakes." It is understood, of course, that the chambers of the locks in passing ships through them are filled with water admitted from the lakes above them, which in each instance is fresh (except for the slight brackishness occurring at times in Miraflores Lake). Therefore, if traffic is heavy a large amount of fresh water reaches the sea level ends of the Canal, reducing the percentage of salinity. It is evident, then, that the water in the locks (exclusive of that in Pedro Miguel Locks, which are in fresh water) may vary from about the saline condition of the inner harbor, when the sea level gates are open, to a sort of half and half mixture of the harbor and lake water to almost fresh, as in the upper flight of Gatun Locks.

Salinity records for the locks are not available, except for one day (June 10, 1935), and for Gatun Locks only. According to hydrometer readings furnished by Mr. Kirkpatrick (without making corrections for temperature) the chambers of the upper level were fresh. No appreciable amount of salt was indicated in the east chamber of the intermediate level immediately after the water had been lowered from a 71- to a 43-foot level, and only slight brackishness was evident in the west chamber of the same level after it had been filled from a 43- to a 71-foot level. The two lowest chambers, however, were decidedly brackish, the salinity varying from about 10,000 to 16,000 parts per million. At the Atlantic entrance (outside the locks) the water was about as salty as that shown for the "Atlantic Entrance (inner harbor)" in Table II.

TABLE I.

Monthly water temperatures in degrees Fahrenheit, surface. (See text for periods of time covered).

Locality	Minimum	Maximum	Average
Balboa Entrance (Inner Harbor) . . . .	69.3	84.9	80.0
Miraflores Lake . . . . .	78.0	84.0	81.0
Gatun Lake . . . . .	80.9	85.0	83.6
Atlantic Entrance (Inner Harbor) . . . .	77.6	85.3	82.1

TABLE II.

Salinities, surface.

Locality	Parts per million
Pacific entrance (Inner Harbor) . . . .	16,000 to 20,000
Miraflores Lake . . . . .	100 to 3,000
Gatun Lake . . . . .	5 to 20
Atlantic entrance (Inner Harbor) . . . .	18,000 to 20,000

It is claimed by employees of the Canal that when the Gatun Locks first were operated dead fish were seen in the locks from time to time, which presumably died from the change in salinity caused by filling the locks with fresh water from Gatun Lake. Dead fish no longer are seen. The employees believe the fish have become "educated" to the necessity of avoiding fresh water.

The extent to which marine fishes have invaded fresh water, nevertheless, is remarkable, as shown by the large number of salt water species listed from fresh or nearly fresh water subsequently. This is true especially of Miraflores Lake where fresh and salt water species seemingly intermingle freely.

#### FISHES USING THE CANAL AND LOCKS AS PASSAGEWAYS.

The species that most logically would be expected to pass through the locks and possibly complete the transit from ocean to ocean, are those inhabiting more or less indiscriminately salt, brackish and fresh water. To this group of fishes in Panama belong some of the guavinas (*Gobiidae*), several species of snook or robalos (*Centropomidae*), some of the so-called marine mojarras (*Gerridae*), a few species of rancons or burros (*Pomadasys*), and the tarpon (*Tarpon atlanticus*).

Among the fishes named the tarpon definitely has completed the transit from the Atlantic to the Pacific, as 4 individuals were present in the lower chamber of Miraflores Locks (east side) when dewatered in 1937. When the gates to the lower flight of the locks are open, as they often are, when

vessels are not actually in transit, nothing remains to prevent the fish from swimming into the sea level end of the Canal and out into Panama Bay.

Tarpons, indeed, have been reliably reported from the Pacific sea level terminus of the Canal, though to date this fish does not seem to have been caught in Panama Bay. While tarpons are present in Gatun Lake at all times, there is as yet no evidence that this fish breeds there, as pointed out by the writer (*Scientific Monthly*, Vol. 44, Mar., 1937, p. 242). Therefore, it may be assumed, for the present at least, that the fish came from the Atlantic (or Caribbean Sea); that they use Gatun Locks as a passageway to Gatun Lake whence they pass on through Culebra Cut, and the Pedro Miguel Locks into Miraflores Lake (where they are seen frequently), and then on through the Miraflores Locks.

Among the guavinas, or fresh water gobies, which inhabit principally fresh and brackish water, *Dormitator maculatus* of the Atlantic slope and shores was taken in the lower chamber, that is, at sea level, of Miraflores Locks. *Leptophilypinus fluviatilis*, another species of the Atlantic side, also was taken in Miraflores Locks, though not in the lower chambers. This species was numerous in the Pedro Miguel Locks and one specimen was secured in Miraflores Lake. On the other hand, *Gobiomorus maculatus*, a species of the Pacific side, was secured in Gatun Lake in company with its near relative *Gobiomorus dormitor*, of the Atlantic side. *Gobiomorus maculatus* is very common in Miraflores Lake, though it was not taken in Pedro Miguel Locks. It conceivably could have reached Gatun Lake without passing through the locks, as a few small Pacific slope streams empty into the Canal above Pedro Miguel Locks. Finally, it seems probable that *Eleotris pisonis*, of the Atlantic side, has crossed over to the Pacific, as shown by some specimens taken in the lower chamber of Miraflores Locks, which appear to be hybrids, that is, a cross between *Eleotris pisonis* and *E. picta*. No typical examples of *E. pisonis* were taken, however, on the Pacific side.

Among the snooks or robalos, some of which range from the shores far up fresh water streams, *Centropomus parallelus*, an Atlantic side species, was taken in Miraflores Lake. To reach this lake the fish had to pass through Pedro Miguel Locks. *Centropomus pectinatus*, which occurs on both coasts of Panama, also was taken in Miraflores Lake. Because of its natural distribution this species may have come from either coast. No positive proof has been found, so far as the writer is aware, that any of the snooks breed in fresh water.

Two species of mojarra (Gerridae), namely, *Eucinostomus californiensis*<sup>3</sup> and *Gerres cinereus*, were taken in the locks and the latter also in Miraflores Lake. However, as these species are common to both coasts of Panama it is not known that they have traversed the Isthmus, though they probably pass through the locks freely.

Specimens of rancon or burro (*Pomadasys*) were taken in Gatun Lake, and in Pedro Miguel Locks and Miraflores Lake. These specimens all appear to be one species, but it is not possible at this time to state whether they are *Pomadasys crocro* from the Atlantic or *P. bayanus* from the Pacific, two nominal species which may not be distinct. Though these fish seem to pass through the locks, it has not been determined whether they have crossed the Isthmus. Neither is it known that they breed in fresh water, though they frequent it.

The small anchovy, *Anchovia parva*, present in large numbers in all three chambers of Gatun Locks in 1935, was common in both chambers of Miraflores Locks in 1937. As this species has not been recorded from the Pacific, it seems possible that a migration has taken place, though it was not taken in Gatun Lake, Pedro Miguel Locks nor Miraflores Lake.

The silverside, *Menidia (Thyrina) chagresi*, though belonging to a

<sup>3</sup> Though I have not been able to date to separate the Atlantic and Pacific coast specimens as to species, other investigators at least have attempted to do so.

family whose members are mostly marine, lives in fresh and brackish water. It was found common in the Chagres Basin during our investigations in 1911 and 1912, before the opening of the Canal. In 1935 it was found in the middle and uppermost chambers in Gatun Locks, and numerous in Gatun Lake. In 1937 several specimens were secured in Pedro Miguel Locks and the lower chamber of Miraflores Locks, presumably a result of a migration from the Atlantic to the Pacific slope through Culebra Cut.

Among the more or less strictly fresh water species the chogorro, *Cichlasoma maculicauda*, an Atlantic slope fish sometimes descending to slightly brackish water, seems to have crossed to the Pacific side, as it was taken in Pedro Miguel Locks, Miraflores Lake and the upper chamber of Miraflores Locks, as well as in the Gatun Locks. Two Atlantic slope species of "sabalo pipon," *Brycon chagrensis* and *B. petrosus*, were taken on the Pacific side, the former in Pedro Miguel Locks and Miraflores Lake, and the latter in the Rio Cocoli, a short distance above Miraflores Lake.

Only one of the numerous species and generally abundant "sardinas," namely *Astyanax fasciatus*, a Pacific slope species, seems definitely to have crossed the divide through Culebra Cut, as it was taken in Gatun Lake. Other species of characins may have crossed through Culebra Cut. However, as several species of this family are common to both slopes, crossing over cannot be determined from specimens.

It was particularly surprising that the abundant "sardina," *Astyanax ruberrimus*, of both slopes, which literally swarms everywhere in Gatun and Miraflores Lakes, did not occur in the locks. Not one specimen even was found in Pedro Miguel Locks, which are in fresh water, though it occurs in abundance above and below them. It was rather surprising also that *Roebooides*, another "sardina," avoids the locks, wherein no specimen was secured. Furthermore, no crossing over nor intermingling of the two easily distinguishable species, *guatemalensis* of the Atlantic slope and *occidentalis* of the Pacific, through Culebra Cut, seems to have taken place, as shown by numerous specimens collected in Gatun and Miraflores Lakes.

The pipefish, *Doryrhamphus (Oostethus) lineatus*, has been reported as having been caught "in transit through the Panama Canal" by Chickering (*Copeia*, No. 173, 1930, p. 85). However, this fish probably inhabits chiefly fresh and brackish water as shown by many specimens taken during our investigation in 1911 and 1912 (Meek and Hildebrand, *Field Mus. Nat. Hist. Pub.*, Zool. Ser., XV, Pt. I, 1923, p. 262), before the opening of the Canal, when none was secured in salt water. In March, 1935, the writer collected 9 specimens in a few hours seining along the shores of Barro Colorado Island, in Gatun Lake. Four of the specimens are males with abdominal pouches filled with eggs, showing that this fish breeds in the Lake, where it probably is a permanent residence. It was not seen in any of the locks, nor in Miraflores Lake. Therefore, it is not known that it frequents the locks, nor that it has crossed the divide through Culebra Cut.

#### INVERTEBRATES OBSERVED AND COLLECTED.

It is stated in the foregoing pages that some fishes are so numerous in parts of the locks at each dewatering (see appended lists for the relative abundance of the various species of fishes observed in the chambers of the locks) that they must find conditions agreeable. In this connection a brief account of the condition of each lock, together with remarks on the invertebrates observed, seems desirable. Many of these lower forms of course are eaten by fish.

The collections of invertebrates of necessity are incomplete, as the water drops rapidly in the dewatering process. After the floors of the different chambers become exposed water remains only in the "manholes" in the floors, and in the sumps, at the gates. Some animals are stranded, but

many more of the free swimming forms manage to reach either the bottom holes or the sumps. In any event, collections must be made quickly. As the writer and his helpers were interested chiefly in securing a representative collection of fishes, to which they gave most of their attention, more than a few invertebrates, even of the larger forms, no doubt escaped notice. Therefore, the collections of these lower forms must be considered far from complete.

*Gatun Locks*: The walls and floors of Gatun Locks (east side), when de-watered in 1935, had not accumulated much sediment or rubbish since the previous overhaul in 1932, though sufficient slush was present on the bottom that the collectors were well covered with mud splattered by stranded fish. Neither were the growths on the walls, gates and floors especially luxuriant. The growth in the uppermost and middle chambers consisted mostly of a hydroid, identified by Prof. Charles McLean Fraser as *Cordylophora lacustris* Allman. This hydroid was most abundant in the nearly fresh water of the uppermost chamber, and little in evidence in the much saltier lowest chamber, wherein that growth was largely replaced by oysters and barnacles.

Clusters of mussel-like bivalves, examples of which were identified as *Brachidontes exustus* Linnaeus by Dr. Paul Bartsch, who furnished identification also for the other molluscs mentioned herein, were present in the middle and lowest chambers of Gatun Locks. The gastropod, *Neritina meleagris* Lam., was numerous in the uppermost chamber, less so in the middle one, and was not observed in the lowest chamber.

Small crabs were present in each chamber of Gatun Locks. However, examples were preserved only from the uppermost one. These were identified by Dr. Mary J. Rathbun, who identified the other crabs mentioned herein also, as *Callinectes sapidus acutidens* Rathbun, and who supplied the following note, "A marine species ranging from each coast of Florida to Rio de Janeiro, Brazil." This crab was inhabiting the nearly fresh water in the uppermost chamber of Gatun Locks.

Small shrimps, too, were present in the Gatun Locks. One species, identified as *Macrobrachium acanthurus* (Wiegmann) by Dr. Waldo L. Schmitt, who identified the other shrimps mentioned herein also, was taken only in the lowest chamber, though it may have been present in the others. Dr. Schmitt remarked, "A fresh water species, ranging from Florida to Brazil and Uruguay, and West Coast of Mexico to Ecuador." Juveniles of another species, provisionally identified as *Macrobrachium olfersii* (Wiegmann), were common in the uppermost chamber, and a third species, *Cran- gon armillatus* (H. Milne-Edwards), was taken in the lowest chamber. Concerning the latter Dr. Schmitt remarked, "A marine species distributed from North Carolina and Bermuda to Brazil; and through the West Indies."

One specimen of *Macrobrachium olfersii* was infested with a bopyrid isopod in the right branchial cavity. This isopod was identified by J. O. Maloney as *Palaegyge meeki* Richardson.

*Pedro Miguel Locks*: The Pedro Miguel Locks, which are in fresh water, though possibly at times very slightly brackish from lockage water from Miraflores Locks, contained mud several inches to a few feet deep (east side). The concrete walls and the iron gates, as high as the permanent water level, were almost entirely covered with a mussel-like bivalve, identified by Dr. Bartsch as *Congeria (Mytilopsis) sallei* Recluz. On the floors of the locks, where objects for attachment were present, clumps of this bivalve also occurred, and under and around the clumps amphipods, probably of the same species as the one from the upper chamber of Miraflores Locks, identified as *Grandidierella megnae* (Giles) by C. R. Shoemaker, were numerous. Unfortunately the specimens collected were lost. No other molluscs or amphipods were noticed, though they may have been present.

Shrimps were rather common, and no doubt are fed upon by some of the fish that inhabit these locks. Dr. Schmitt identified 4 species, namely,



*Penaeus stylirostris* Stimpson, *Macrobrachium jamaicense* (Herbst), *M. acanthurus* (Wiegmann), and *Palaemonetes* sp. Dr. Schmitt referred to the one first named as a marine species, the next two as well known fresh water shrimps, and the last one as most likely a fresh water form. No crabs were seen in these locks.

*Miraflores Locks*: The fauna of the Miraflores Locks was much more diversified than that of the Pedro Miguel Locks, no doubt because the water ranges from salt to nearly fresh. The upper chamber contained fully as much sediment as the Pedro Miguel Locks, but the lower one contained much less. The walls of the upper chamber were almost as fully over-grown as Pedro Miguel Locks with the same species of bivalve, but in the lower chamber this mollusc was missing, presumably because of the higher salinity. This bivalve occurred also in clusters on the floor of the upper chamber wherever there were objects reaching above the bottom slush to which it could attach itself. Among these clusters were numerous amphipods, presumably all of the species identified as *Grandidierella megnae* (Giles) by Mr. Shoemaker from the single specimen, of many collected, not lost in shipment.

In addition to the abundant bivalve mollusc a scant growth of a hydroid, somewhat doubtfully identified (because of the unsatisfactory condition of the specimens) as *Bimeria gracilia* Clark by Prof. Fraser, was present in the upper chamber. In the lower chamber only a few clumps of the hydroid were seen attached to objects on the floor.

The abundant growths of the bivalve and hydroid mentioned, of the upper chamber, were replaced in large part by barnacles in the lower one. A few other attached forms of which only scattered examples were seen, was the sponge, identified by M. W. de Laubenfels as a cosmopolitan form, *Haliclona permollis* (Bowerbank), and the alcyonarian, *Leptogorgia alba* Duchassaing & Michelotti, as identified by Miss Elisabeth Deichmann, who referred to it as "one of the most common forms in the lava pools off Panama."

In the lower chamber of Miraflores Locks the wooden beams against which the bottoms of the iron gates close were badly infested with teredo, of which no examples were secured. Only one mollusc, the gastropod, *Thais kiosquiformis* Duclos, in addition to the numerous bivalve already mentioned, was taken in the upper chamber. This gastropod was found also in the lower chamber with four others, identified by Dr. Bartsch as *Phyllonotus radix* Gmelin, *Pustularia pustulata* Lamarck, *Triumphis distorta* Wood, and *Cymatium* (*Linatella*) *wiegmanni* Anton. Limpids were fairly common in the lower chamber. Examples of two species, *Crepidula aculeata* Gmelin and *C. incurva* Broderip, were preserved. Small squids were common in the sump at the lowest gates of the locks. The examples transmitted to the National Museum were identified as *Loligo* sp.

Crabs and shrimps were in evidence in both chambers of Miraflores Locks and were numerous in the bottom holes after the water had been pumped somewhat below floor level. The crabs in particular were difficult to catch in these holes, as they clung closely to the walls from which they were not readily removed, and generally dived out of reach of a dipnet after some agitation. Because of the difficulty of catching crabs and shrimps, and more particularly because of lack of time, more than a few species surely were missed.

Only two species of crab, identified by Dr. Rathbun as *Panopeus rugosus* A.M.E., and *Callinectes arcuatus* Ordway, were collected in the upper chambers. These two were taken also in the lower chamber with *Panopeus chilensis* M. Edw. & Lucas and *Petrolisthes armatus* (Gibbes). The occurrence of the blue crab, *Callinectes sapidus* Rathbun in fresh water recently was discussed by Gordon Gunter (*Science*, Vol. 87, Jan. 28, 1938, p. 87). It is not surprising, therefore, that other species of the genus also enter brackish and fresh water.

Seven species of shrimp were collected in the upper chambers of Miraflores Locks, which Dr. Schmitt identified as *Penaeus brevirostris* Kingsley, *Macrobrachium jamaicense* (Herbst), *M. acanthurus* (Wiegmann), *Palaemonetes* sp., and two species of snapping shrimp, *Crangon*, unidentifiable as to species because of the "meager and incomplete material." and because of "our too limited knowledge of the west American species."

Four species of shrimp collected in the upper chambers, namely *Macrobrachium acanthurus* (Wiegmann), *Palaemonetes* sp., and the two unidentifiable species of *Crangon*, were taken also in the lower chamber, with the three following species not secured in the upper one: *Penaeus stylirostris* Stimpson, *P. occidentalis* Streets and a third unidentifiable *Crangon*. Besides the shrimps, a stomatopod, *Chloridella aculeata* (Bigelow), was taken.

Dr. Schmitt referred to *Macrobrachium jamaicense* (taken in Pedro Miguel Locks and the upper chamber of Miraflores Locks), and *M. acanthurus* (found in all three levels) as "well known fresh water shrimps," and he regarded it likely that *Palaemonetes* sp. (taken in all three levels) also is a fresh water form. Though these species live chiefly in fresh water they appear to enter brackish water, or even at times salt water. The rest of the shrimps apparently may be regarded as salt and brackish water forms.

#### ANNOTATED LIST OF FISHES FROM THE LOCKS OF THE PANAMA CANAL.

The nomenclature and sequence of families of the earlier works by Meek & Hildebrand (a. "The Fishes of the Fresh Waters of Panama," *Field Mus. Nat. Hist. Pub., Zool. Ser.*, X, No. 15, 1916, pp. 217-374; b. "The Marine Fishes of Panama," *Field Mus. Nat. Hist. Pub., Zool. Ser.*, XV, No. 215, Pt. I, 1923; No. 226, Pt. II, 1925; and No. 249, Pt. III, 1928, 1045 pages) have been followed as far as it seemed permissible to do so. In order to retain as far as possible this nomenclature and sequence, the rearrangement and splitting of some of the old families (as for example Siluridae, Serranidae, Sciaenidae, and Gobiidae), as well as some of the genera, by some recent writers have not been adopted. This course was followed chiefly for the convenience of those perhaps not entirely familiar with the nomenclature who may wish to check the lists against the descriptions and accounts in the earlier publications.

The large number of marine species present in the locks and their great tolerance for fresh or nearly fresh water are interesting facts shown in these lists.

#### GATUN LOCKS.

The level or levels at which the specimens collected in the east side of the locks were taken are shown, without stating that they are from the east side. Those from the west side, collected by workmen, were not kept separate, and therefore are listed simply as from the "west side." In other words, all specimens listed are from the east chambers of the locks unless otherwise stated.

The collections in the east chambers were made by me and helpers from February 20 to 24, 1935. Those from the west side were made by workmen, as already stated, in January, 1935, before my arrival on the Canal Zone.

The marine gobies listed in this paper were kindly identified by Isaac Ginsburg, who is a specialist on that group of fishes.

#### FAMILY MYRIDAE. WORM EELS.

##### *Myrophis punctatus* Lütken.

Lowest Chamber: 1 specimen, 204 mm. long, picked up in bottom slush.

## FAMILY ELOPIDAE.

**Tarpon atlanticus** (Cuvier & Valenciennes). Tarpon; "Sabalo real."

Uppermost Chamber: A half-dozen or so large ones, all removed by laborers, except one, before the writer could reach them. One female, about 150 cm. long, with small roe, examined.

Middle Chamber: 2 males, ripe or nearly so, 100 and 106.5 cm. long; 6 females, respectively 97, 108, 109, 153, 167 and 199 cm. long, the largest one with well developed gonads, the others entirely undeveloped.

The tarpon, locally known as sabalo real, i.e., king shad, is highly prized as a food fish by the natives and the West Indian negro immigrants. This fish occurs regularly in Gatun Lake and it has passed on to the Pacific locks (see lists). It apparently does not spawn in the fresh waters of the Canal. Therefore, it evidently passes through the locks, which it may use as a feeding ground also. (For a more extended account see "The Tarpon in the Panama Canal," by the author, *Scientific Monthly*, Vol. 44, Mar., 1937, pp. 239-248, 4 figs.). The tarpon has a modified air bladder, which is developed somewhat as a lung, enabling it to breathe air at least in part. This adaptation presumably aids it in tolerating fresh water.

**Elops saurus** Linnaeus. "Bonyfish"; Big-eyed herring.

Middle Chamber: Hundreds of fish present, probably 1,000 pounds or more; 20 individuals (selected at random) consisted of 7 males, 56.5 to 62 cm. long; and 13 females, 63.5 to 73 cm. long; all with large roe, indicating that spawning time was near at hand.

Lowest Chamber: About one-sixth as many fish as in middle chamber.

West Side: Several, according to workmen; 2 preserved.

The gillraker counts for 18 specimens are 13 and 14, showing that no crossing over had taken place, as the Pacific Coast bonyfish (*Elops affinis*) has 18 to 24 gillrakers on the lower limb of the first arch. There is, in fact, no evidence that this species enters the fresh water of the Canal. It seems probable, therefore, in view of the large number present, that this species uses the locks as a feeding ground. Though the closely related Pacific coast species is not uncommon in Panama Bay, not a single individual was seen in the locks at the Pacific end of the Canal.

This fish was rejected by the natives and negroes as unfit for food, and the large quantity stranded had to be disposed of by burial. This species, nevertheless, is seen in the local markets from time to time.

## FAMILY ENGRAULIDAE. ANCHOVIES.

**Anchovia parva** Meek & Hildebrand. "Sardina."

Numerous in all chambers, many in bottom holes of locks, mostly small, almost transparent; many specimens preserved.

This anchovy was not taken in Gatun Lake, but specimens were secured in Miraflores Locks. This species heretofore was not known from the Pacific.

**Anchovia spinifer** (Cuvier & Valenciennes). "Sardina."

A single specimen, 88 mm. long, was taken in the locks, shortly after they were refilled, by Felipe Torris, and preserved by Dr. J. R. Martin. It was not seen when the locks were dewatered.

This species, reported from both coasts of Panama, apparently is rare on the Atlantic coast. It was numerous in the locks on the Pacific end of the Canal.

## FAMILY BELONIDAE. SALT WATER GARFISH.

***Tylosurus raphidoma* (Ranzani).**

West Side: 1 mutilated specimen 62.5 cm. long.

## FAMILY ATHERINIDAE. SILVERSIDES.

***Menidia (Thyrina) chagresi* Meek & Hildebrand.**

Uppermost Chamber: 4 juveniles, 13 to 18 mm. long.

Middle Chamber: 1 specimen 50 mm. long.

This silverside is very common in Gatun Lake. So far as known, it does not enter salt water. Several specimens were taken in the locks at the Pacific end of the Canal, probably the result of a migration through the Canal. These fish were thought to be young tarpons by some of the native tarpon fishermen.

## FAMILY MUGILIDAE. MULLETS; "LIZA."

***Mugil brasiliensis* Agassiz.**

Middle Chamber: 5 large fish, ranging in length from 56.5 to 86 cm.; 2 large females, respectively 82.5 and 86 cm. long, contained large roe.

Although this mullet enters brackish water freely in Panama, it is not known to pass through the locks into Gatun Lake.

## FAMILY SPHYRAENIDAE. BARRACUDAS.

***Sphyraena* sp. Barracuda.**

None seen in 1935; reliably reported from earlier dewaterings, generally one or two large ones present.

## FAMILY CARANGIDAE. CAVALLAS.

***Caranx hippos* (Linnaeus). "Jack."**

Middle Chamber: Many (500 or so) all large; 19 individuals (selected at random) consisted of 11 males, ranging in length from 69 to 88 cm., and 8 females, varying from 67 to 98 cm. in length; all except 4 males with large or developing roe.

Lowest Chamber: About half as many as in middle chamber; 11 individuals (selected at random) consisted of 4 males, 67.5 to 83 cm. long, and 7 females, 76 to 100 cm. long; all of these fish and a dozen or so others, cut open but not measured, contained large or developing roe, showing that spawning time was near at hand.

West Side: 1 specimen 50 cm. long.

This fish quite surely does not pass through the locks into fresh water. It, indeed, was not present in the uppermost chamber, though numerous in the middle one. The locks apparently are a feeding ground for the jack, which is valued locally as a food fish. The largest individual noticed was 100 cm. (40 in.) long, which may be near the maximum size attained. Though it is common also on the Pacific coast of Panama, it was not numerous in the locks at that end of the Canal.

***Selene vomer* (Linnaeus). Moonfish.**

West Side: A single specimen 320 mm. long.

## FAMILY CENTROPOMIDAE. ROBALOS; SNOOK.

**Centropomus undecimalis** (Bloch). Robalo; Snook.

Middle Chamber: 1 specimen 275 mm. long.

Most of the species of the genus ascend brackish and fresh water streams in Panama. However, this species was not taken in fresh water during the recent investigation, nor in earlier (1911 and 1912) investigations.

**Centropomus parallelus** Poey.

This species was not seen in the locks. However, three fish, respectively 250, 270 and 300 mm. long, were taken in Gatun Lake near Gamboa. It was reported from Barro Colorado Island by Breder (*Zoologica*, IX, 1933, p. 568). Since there is as yet no evidence that this Atlantic coast fish breeds in fresh water, it apparently may be assumed that the specimens collected had passed through the Gatun Locks. Specimens were secured in Miraflores Lake, indicating a migration through Pedro Miguel Locks.

## FAMILY SERRANIDAE. SEA BASSES.

**Promicrops itaiara** (Lichtenstein). Spotted jewfish.

Middle Chamber: 1 specimen 208 mm. long.

Lowest Chamber: 1 specimen, juvenile, 24 mm. long; identification uncertain because of extreme youth. The jewfish, which is common to both coasts of Panama, occurred also in the Miraflores Locks.

**Rypticus saponaceus** (Bloch & Schneider). Soapfish.

Lowest Chamber: 3 specimens, respectively 133, 140 and 150 mm. long; picked up from bottom slush. Many more were present.

West side: 6 specimens, 123 to 145 mm. long.

## FAMILY LUTIANIDAE. SNAPPERS.

**Lutianus griseus** (Linnaeus). Gray or mangrove snapper.

Lowest Chamber: 3 specimens, 100 to 110 mm. long, preserved. Examined six others ranging in length from 370 to 540 mm. for spawning condition, all of which were undeveloped. This species was scarcely as numerous as the dog snapper.

West Side: 2 specimens, 150 and 225 mm. long.

**Lutianus jocu** (Bloch & Schneider). Dog snapper.

Middle Chamber: 3 specimens, 60, 235 and 260 mm. long.

Lowest Chamber: 16 specimens preserved, ranging in length from 34 to 310 mm. Many others were present; examined six ranging from 270 to 335 mm. in length for spawning condition, which were all undeveloped.

West Side: 8 specimens, varying in length from 62 to 300 mm.

**Lutianus apodus** (Walbaum). Schoolmaster.

Middle Chamber: 2 specimens, respectively 205 and 250 mm. long.

Lowest Chamber: 4 specimens preserved, ranging in length from 245 to 290 mm. Several others were present, but the species was less numerous than the dog snapper.

**Lutianus synagris** (Linnaeus). Lane snapper.

Lowest Chamber: Only 4 small ones, ranging in length from 106 to 152 mm.

West Side: 1 specimen 105 mm. long.

## FAMILY HAEMULIDAE. GRUNTS.

***Pomadasys crocro*** (Cuvier & Valenciennes). Ranco.

Uppermost Chamber: 14 small specimens, 36 to 57 mm. long.

This fish was taken also in Gatun Lake, near Gamboa. In earlier investigations (1911 and 1912) specimens were collected all the way from strictly salt water at Porto Bello to fresh water, above many rapids, in the upper Chagres River. It seems probable that this fish passes through the locks, as no evidence has been secured indicating that it reproduces in fresh water. Specimens of this species, or the closely related *P. bayanus*, were taken in Pedro Miguel Locks and Miraflores Lake.

## FAMILY SPARIDAE. PORGIES.

***Archosargus aries*** (Cuvier & Valenciennes). Sheepshead.

West side: 1 specimen 325 mm. long.

This fish is new to the fauna of Panama. The species originally was described from Rio de Janeiro and Maracaibo, and later recorded from Belize, Honduras.

## FAMILY GERRIDAE. MARINE MOJARRAS.

***Eucinostomus californiensis*** (Gill).

Uppermost Chamber: 11 juveniles, 24 to 32 mm. long. This species, as here understood, is common to both coasts of Panama. Specimens were taken also in Miraflores Locks and Miraflores Lake, but none at intermediate points. Though it ranges into brackish water streams, it is not known to enter strictly fresh water in Panama.

***Diapterus plumieri*** (Cuvier & Valenciennes).

Uppermost Chamber: 1 individual, quite surely of this species, was seen in a bottom hole but not captured.

Middle Chamber: 3 specimens, respectively, 270, 270 and 315 mm. long preserved. Others were seen.

West Side: 2 specimens, 330 and 340 mm. long.

## FAMILY SCIAENIDAE. SEA TROUT, CROAKERS, ETC.

***Bairdiella*** sp.

Lowest Chamber: 12 postlarvae, 8 to 10 mm. long, probably belong to this genus.

***Bairdiella ronchus*** (Cuvier & Valenciennes).

Lowest Chamber: 8 specimens, ranging in length from 33 to 95 mm.

## FAMILY POMACENTRIDAE.

***Pomacentrus fuscus*** Cuvier & Valenciennes.

Lowest Chamber: 1 specimen 75 mm. long.

## FAMILY CICHLIDAE. MOJARRAS DE RIO.

***Cichlasoma maculicauda*** Regan.

Uppermost Chamber: 6 specimens, varying in length from 82 to 210 mm. This Atlantic slope species is not confined to strictly fresh water, as it

frequently was taken in brackish water in Panama during earlier investigations (1911 and 1912). It apparently has crossed the divide through Culebra Cut, as specimens were secured in Pedro Miguel and Miraflores Locks as well as in Miraflores Lake.

FAMILY GOBIIDAE. GOBIES; GUAVINAS.

**Gobiomorus dormitor** Lacépède.

Uppermost Chamber: 7 specimens, 35 to 75 mm. long.

Lowest Chamber: 1 specimen 73 mm. long.

This fish was not taken in strictly salt water in Panama during the recent investigation nor the earlier ones (1911 and 1912). It most commonly was found in quiet brackish water, though occasionally far upstream. It, also, was secured in Gatun Lake in 1935.

**Electris pisonis** (Gmelin).

Lowest Chamber: 7 specimens, 15 to 75 mm. long, preserved. Others were seen.

This species ranges from brackish to fresh water. It apparently has crossed the divide to the Pacific side locks where it seems to have hybridized with its closely related congener, *picta*. (See Hildebrand, *Field Mus. Nat. Hist. Pub.*, XXII, 1928, pp. 344-347).

**Electris isthmensis** Meek & Hildebrand.

Uppermost Chamber: 12 specimens, 20 to 60 mm. long, preserved. This species was common in the bottom holes after the flight had been drained, but it was difficult to catch.

This fish ranges from salt to fresh water, but it appears to be most numerous in brackish water. No evidence of crossing over was found, though nothing would appear to prevent it.

**Leptophilypnus fluviatilis** Meek & Hildebrand.

Uppermost Chamber: 28 specimens, 15 to 45 mm. long, preserved. It is very common, like the preceding species, in the bottom "manholes" where many adhering to the walls could be seen.

Middle Chamber: 2 specimens, 49 and 52 mm. long.

Lowest Chamber: 1 specimen 35 mm. long.

Three specimens of this species were taken in Gatun Lake at Barro Colorado Island. It apparently ranges from brackish to fresh water.

This species seems to have crossed the divide to the Pedro Miguel and Miraflores Locks.

**Lophogobius cyprinoides** (Pallas).

Lowest Chamber: 25 specimens, 30 to 81 mm. long, preserved; many present.

This goby previously was known from Panama from only one specimen, taken at Porto Bello.

**Gobionellus boleosoma** (Jordan & Gilbert).

Uppermost Chamber: 1 specimen 17 mm. long.

Lowest Chamber: 2 specimens, 27 and 30 mm. long.

**Bathygobius soporator** (Cuvier & Valenciennes).

Middle Chamber: 1 specimen 38 mm. long.

Lowest Chamber: 7 specimens, 25 to 59 mm. long, preserved; many present.

West Side: 1 specimen 58 mm. long.

This species apparently does not enter fresh water.

**Garmannia hildebrandi** Ginsburg.

Uppermost Chamber: 26 specimens, 13 to 37 mm. long, type material.

This goby was taken also in the Pedro Miguel Locks.

FAMILY BATRACHOIDIDAE. TOADFISHES.

**Amphichthys cryptocentrus** (Cuvier & Valenciennes).

Lowest Chamber: 2 specimens, 72 and 75 mm. long.

FAMILY BLENNIIDAE. BLENNIES.

**Hyleurochilus** sp.

Lowest Chamber: 1 specimen 46 mm. long. This probably is a new species.

**Blennius** sp.

Lowest Chamber: 4 specimens, 25 to 37 mm. long. This may be a new species.

FAMILY ANTENNARIIDAE. FROGFISHES.

**Antennarius scaber** (Cuvier).

Lowest Chamber: 1 specimen 45 mm. long.

PEDRO MIGUEL LOCKS.

All specimens noted in the following list were taken in the east side of the locks, no collection having been made in the west side. The Pedro Miguel Locks are situated in fresh water, as stated elsewhere, and as the fresh water species of the Canal Zone in large part seem to shun the locks, comparatively few species, or even individuals, were present when the east side of these locks was dewatered February 20, 1937. It will be noticed that most of the species recorded are more or less regular inhabitants of brackish water. Several marine forms are included in the list, which in this instance have invaded fresh water.

FAMILY ELOPIDAE.

**Tarpon atlanticus** (Cuvier & Valenciennes). Tarpon.

This species was not present in the east side of the locks, but Mr. Myrick, the superintendent of the locks, stated that several were stranded in the west side when dewatered in January, 1937. Several tarpons were present in Miraflores Locks. It was seen also in Miraflores Lake.

FAMILY ENGRAULIDAE. ANCHOVIES.

**Anchovia lucida** (Jordan & Gilbert).

Six specimens, 93 to 106 mm. long.

This species was found in Miraflores Locks also.

**Anchovia spinifer** (Cuvier & Valenciennes).

Many specimens of this anchovy were taken, ranging upward to 160



mm. in length. It was numerous also in Miraflores Locks. No evidence was secured, indicating that this anchovy, which inhabits both coasts of Panama, invades the fresh water between Gatun and Pedro Miguel Locks.

## FAMILY CHARACINIDAE.

***Astyanax fasciatus*** (Cuvier). "Sardina."

This Pacific slope species was taken in Gatun Lake. Though no specimen was seen in Pedro Miguel Locks when dewatered, it may have passed through them to reach Gatun Lake.

***Brycon chagrensis*** (Kner). "Sabalo pipon."

A single specimen of this common Atlantic slope fish, 295 mm. long, was found in Pedro Miguel Locks. Many more were taken in Miraflores Lake, where the species apparently is now well established. To reach Miraflores Lake, the fish originally very probably descended from Gatun Lake and Culebra Cut, through the Pedro Miguel Locks.

***Brycon petrosus*** Meek & Hildebrand. "Sabalo pipon."

Eight small specimens, 49 to 76 mm. long, were taken in the Rio Cocoli, just above Miraflores Lake. This Atlantic slope fish presumably reached the Rio Cocoli from Miraflores Lake by descending from Gatun Lake and Culebra Cut through Pedro Miguel Locks.

## FAMILY ATHERINIDAE. SILVERSIDES.

***Menidia (Thyrina) chagresi*** Meek & Hildebrand.

Four specimens, 45 to 70 mm. long, of this Atlantic slope fresh water silverside were secured. It was taken also in Miraflores Locks. This small species, which usually does not exceed a length of about 120 mm., has been mistaken by some Canal Zone residents for young tarpon.

## FAMILY MUGILIDAE. MULLET.

***Chaenomugil proboscideus*** (Günther).

A single small specimen 37 mm. long.

***Mugil curema*** Cuvier & Valenciennes.

Three small specimens, 41 42 and 44 mm. long. This species was taken also in Miraflores Locks and Miraflores Lake. It occurs on both coasts of Panama. No evidence indicating that it has invaded the fresh water between Pedro Miguel and Gatun Locks was secured.

## FAMILY CENTROPOMIDAE. ROBALOS; SNOOK.

***Centropomus parallelus*** Poey.

Although this Atlantic coast fish was not taken in Pedro Miguel Locks, it was secured in Miraflores Lake, where it seems to be common. To reach this lake it apparently had to pass through Pedro Miguel Locks.

***Centropomus robalito*** Jordan & Gilbert.

Four specimens 80 to 125 mm. long. Many more were seen and taken in Miraflores Lake, though none was seen in Miraflores Locks, through which they presumably had to pass to reach Miraflores Lake and Pedro Miguel Locks.

**Centropomus aramatus** Gill.

Three specimens, 220, 223 and 240 mm. long. It was not seen in Miraflores Locks through which it presumably had to pass to reach the upper locks.

## FAMILY LUTIANIDAE. SNAPPERS.

**Lutianus novemfasciatus** Gill.

One specimen 335 mm. long was preserved. It is quite certain that others were present, but disappeared by the "route of the fish-hungry." It also occurred in Miraflores Locks.

This snapper evidently has great tolerance for fresh water, but to date it is not known to have advanced into the fresh water of the Canal beyond the Pedro Miguel Locks.

**Lutianus colorado** Jordan & Gilbert.

Three specimens, 330, 430 and 580 mm. in length, were preserved, and others were seen. It was secured also in Miraflores Locks and Miraflores Lake.

## FAMILY HAEMULIDAE. GRUNTS.

**Pomadasy bayanus** Jordan & Evermann.

Two small specimens, 27 and 50 mm. long. Two considerably larger specimens, 250 and 310 mm. long, were taken in Miraflores Lake. It was not seen in Miraflores Locks.

This fish probably is not distinct from *P. crocro* of the Atlantic, which was secured in Gatun Locks and Gatun Lake.

## FAMILY SCIAENIDAE. CROAKERS, SEA TROUT, ETC.

**Cynoscion albus** (Günther). "Yellow corbina."

Three specimens, 153, 225 and 305 mm. long. This species was taken also in the Miraflores Locks.

## FAMILY CICHLIDAE. MOJARRAS DE RIO.

**Cichlasoma maculicauda** Regan. "Chogorro."

Three specimens, 260, 293 and 300 mm. long. This Atlantic slope fish seems well established and common in Miraflores Lake where numerous individuals were taken, ranging upward to 320 mm. in length. It was taken also in Miraflores Locks and Gatun Locks and Gatun Lake.

## FAMILY GOBIIDAE. GOBIES; GUAVINAS.

**Gobiomorus maculatus** (Günther). "Guavina."

This Pacific slope fish was found in Gatun Lake, where 2 specimens, 127 and 210 mm. long, were taken not far below Madden Dam. Though no specimens were secured in Pedro Miguel Locks the species presumably reached Gatun Lake by passing through these locks. This fish is common in Miraflores Lake, below Pedro Miguel Locks.

**Eleotris picta** Kner & Steindachner. "Guavina."

Twelve specimens, 35 to 480 mm. long, preserved. This species was numerous in the locks, where specimens up to 495 mm. in length were

measured. It is common in Miraflores Lake, and it was found also in Miraflores Locks.

No evidence indicating that this fish has passed through Culebra Cut to Gatun Lake was obtained. However, signs of the hybridization of this species and its closely related Atlantic slope congener, *pisonus*, was found. This apparent crossbreeding is discussed in another paper (*Field Mus. Nat. Hist. Pub., Zool. Ser., XXII, 1928, pp. 344 to 347*).

***Leptophilypnus fluviatilis* Meek & Hildebrand.**

This Atlantic slope species was numerous in the "manholes" in the floor of the locks, where it seemed so much at home that it may be a permanent resident. Here it clings, very goby-like, to the walls of the holes. Thirty-five specimens 20 to 33 mm. long were preserved. This fish was taken also in Miraflores Locks and Miraflores Lake.

***Garmannia hildebrandi* Ginsburg.**

This species was obtained also in the uppermost chamber of Gatun Locks. Four specimens, 19 to 35 mm. long, were secured in the Pedro Miguel Locks, type material.

***Garmannia homochroma* Ginsburg.**

Ten specimens, 12 to 33 mm. long were preserved, type material.

FAMILY SOLEIDAE. SOLES.

***Achirus fluviatilis* Meek & Hildebrand.**

This species was fairly common in the "manholes" in the floor of the locks, where it was rather difficult to catch. Five specimens, 19 to 34 mm. long, were preserved. It was taken also in the Miraflores Locks.

MIRAFLORES LOCKS.

Collections were made by the writer and assistants in the two chambers of the west side of the Miraflores Locks, when dewatered from March 24 to 29, 1937, and in the east side by Dr. A. O. Foster of the Gorgas Memorial Laboratory, Panama City, on April 28 and 29, 1937. The specimens secured in the upper and lower chambers of the west side were all kept separate and most of those from the east side similarly were labeled as to the level in which they were taken. When the level is known it is given in the following list.

FAMILY CARCHARHINIDAE. GRAY SHARKS.

***Carcharhinus* sp.**

Lower Chamber, East Side: 1 specimen, a partial skin, about 950 mm. long; a young male. Dr. Foster reported that 3 other sharks, similar to the one preserved, were present. To date the writer has not succeeded in identifying the specimen.

FAMILY SILURIDAE. CATFISH (MARINE).

***Sciadeichthys troschelii* (Gill).**

Upper Chamber, West Side: 3 specimens, 440, 470 and 490 mm. long, were preserved. Many others, supposedly of this species, were seen.

Many males of this and other species carried eggs and young in the mouth, which sometimes were dropped when the fish became distressed as

the water receded. In places in both chambers (west side) the floor of the locks was fairly covered with eggs and young catfish with large yolksacs. A male of this species examined in the laboratory retained a single young, 70 mm. long, with a large yolksac, in his mouth. One might judge that this young could easily have reached a length of 100 mm. (4 inches) on the large amount of yolk remaining. It would seem probable, then, that the young of this species are retained and cared for in the mouth of the male parent until they reach the comparatively large size of around 100 mm.

***Galeichthys seemanni* (Günther).**

Lower Chamber, West Side: 1 specimen, 360 mm. long, was preserved. According to my field notes this species was very common. However, as this and the next mentioned closely related species were not distinguished in the field, it seems probable that both were present in some abundance.

***Galeichthys jordani* (Eigenmann & Eigenmann).**

East Side: 1 specimen, 375 mm. long, was preserved.

This species is closely related to the preceding one from which it is distinguished with difficulty. This species and the foregoing ones very probably were present in the east side, though no specimens were preserved.

***Galeichthys dasycephalus* (Günther).**

Upper Chamber, West Side: 4 specimens, each about 65 mm. long, retaining a large yolksac, evidently dropped by the parent, were preserved.

Lower Chamber, West Side: 1 adult female 353 mm. long; 1 young 80 mm. long with yolk fully absorbed; 4 young removed from mouth of male parent, respectively 52, 54, 55 and 56 mm. long. These young retained a very large yolksac, measuring about 17 mm. in diameter.

According to my field notes this species was very numerous in the locks. It no doubt was present also in the east chambers, though no specimens were preserved.

***Arius multiradiatus* Günther.**

Upper Chamber, West Side: 1 specimen 250 mm. long.

Lower Chamber, West Side: 1 specimen, a male 287 mm. long, with eggs 6 mm. in diameter in the mouth.

FAMILY MURAENESOCIDAE. EELS.

***Neoconger vermiformis* Gilbert.**

This eel was common in the bottom silt of all four chambers. Thirty-six specimens, ranging in length from 42 to 152 mm., were preserved. Many more could have been taken. Specimens under about 75 mm. in length are glassy; the larger ones are pinkish. This eel previously had not been taken in shallow water at Panama.

***Hoplunnis* sp.**

Lower Chamber, West Side: 1 specimen 272 mm. long. I have not yet been able to identify this eel, and in fact am not certain that it belongs to the genus *Hoplunnis*. Upon further study it may prove to be new.

FAMILY MYRIDAE. WORM EELS.

***Myrophis vafer* Jordan & Gilbert.**

Lower Chamber, West Side: 1 specimen 68 mm. long.

## FAMILY ELOPIDAE.

**Tarpon atlanticus** (Cuvier & Valenciennes). Tarpon; "Sabalo real."

Upper Chamber, West Side: 1 female, with undeveloped gonads, 131.25 cm. (52.5 inches) long, became stranded. There was none present in the lower chamber of the west side.

Upper Chamber, East Side: 6 tarpons, ranging in length from 118 cm. (47 inches) to 162.5 cm. (65 inches), present at this level. A female, 141 cm. (56½ inches) long, contained well developed roe.

Lower Chamber, East Side: Four individuals, 2 males and 2 females, were present, ranging from 122.5 cm. (49 inches) to 150 cm. (60 inches) in length. The smallest one, a female, weighed 32 pounds, and the largest one, a male, weighed 57 pounds.

No tarpon were present in the east side of the Pedro Miguel Locks when dewatered in 1937, though reported from the west side, as stated in the preceding list. This species was seen in Miraflores Lake and it has been reliably reported from the sea level end of the Canal below Miraflores Locks. The tarpon, an Atlantic species, then, has completed the transit through the Canal.

## FAMILY CLUPEIDAE. HERRINGS.

**Sardinella stolidifera** (Jordan & Gilbert).

Upper Chamber, West Side: This species was very numerous; 15 specimens, ranging from 95 to 130 mm. in length, were preserved.

Lower Chamber, West Side: This small herring was somewhat less numerous at this level than in the higher one. Eleven specimens, ranging from 51 to 132 mm. in length, were retained for the collection.

It was taken also in Miraflores Lake. It is a rather conspicuous fish because of its very bright, broad, silvery, lateral band.

**Ilisha fürthii** (Steindachner).

Upper Chamber, West Side: A single specimen 150 mm. long.

**Odontognathus** sp.

Lower Chamber, West Side: 1 specimen 77 mm. long.

Lower Chamber, East Side: 3 specimens, 52, 53 and 62 mm. long.

Because of the immaturity of the specimens it has not been possible to identify them with any degree of certainty even as to the genus.

## FAMILY ENGRAULIDAE. ANCHOVIES.

**Anchovia balboae** (Jordan & Seale).

Lower Chamber, West Side: 4 specimens, each close to 90 mm. in length.

This is the species listed as *A. brevirostris* in our earlier work (1923, p. 198). The name, *brevirostris*, however, is regarded as preoccupied by a Brazilian species of this genus.

**Anchovia naso** (Gilbert & Pierson).

Lower Chamber, West Side: 3 specimens, 60, 62 and 63 mm. long.

Lower Chamber, East Side: 1 specimen 52 mm. long.

This species was not numerous in the locks.

**Anchovia parva** Meek & Hildebrand.

Lower Chamber, West Side: 15 specimens, 43 to 65 mm. long.

Upper Chamber, East Side: 62 specimens, 35 to 62 mm. long.

Lower Chamber, East Side: 12 specimens, 33 to 50 mm. long.

This small anchovy heretofore was recorded only from the Atlantic coast of Panama and Trinidad. The specimens have been carefully compared with specimens from the Atlantic coast of Panama (the type locality), without detecting any differences. This species was numerous in the Gatun Locks, even in the uppermost chamber. It was not taken, however, in Gatun Lake, the Pedro Miguel Locks, nor in Miraflores Lake. Therefore, evidence indicating that it has crossed the Isthmus through the Canal is lacking. Its presence in abundance in the uppermost flight of the Gatun Locks, nevertheless, shows that it has great tolerance for fresh water, and the possibility that it has crossed definitely exists.

***Anchovia ischana*** (Jordan & Gilbert).

This anchovy was numerous in all four chambers of the locks. Many specimens, 47 to 93 mm. in length, were preserved.

The great abundance of this species, as well as other anchovies, probably attracts some of the larger fish to the locks.

***Anchovia lucida*** (Jordan & Gilbert).

Upper Chamber, West Side: 1 specimen 85 mm. long.

Lower Chamber, West Side: 18 specimens, 80 to 97 mm. long.

Lower Chamber, East Side: 1 specimen 92 mm. long.

This species was found also in the Pedro Miguel Locks, showing that it can endure fresh water.

***Anchovia curta*** (Jordan & Gilbert).

Although this anchovy was not taken in the locks it seems to belong to this list as 10 specimens, 22 to 54 mm. in length, were taken in Miraflores Lake above the locks. To reach this lake it presumably had to pass through Miraflores Locks.

Its tolerance for fresh water suggests that this anchovy could traverse the Isthmus, but to date no evidence indicating that it has done so has been found.

***Anchovia spinifer*** (Cuvier & Valenciennes).

This species was very numerous in every chamber of the locks. Many specimens, ranging from 33 to 165 mm. in length, were preserved.

It was common also in Pedro Miguel Locks, and a single specimen was secured in Gatun Locks, though not at intermediate points.

As this anchovy was recorded from both coasts of tropical America before the completion of the Canal, it would be impossible to determine whether crossing over has taken place from the study of specimens. Its tolerance for fresh water apparently would enable it to complete the transit.

Its great abundance in the locks was surprising because it was not secured on either coast of Panama during our earlier extensive collecting.

Many of the larger specimens were very conspicuous because of their bright orange color, though others were plain silvery.

The great abundance of this fish in the locks very probably helps to attract many large predatory species.

***Anchovia panamensis*** (Steindachner).

Upper Chamber, West Side: 4 specimens, 58 to 72 mm. long.

Lower Chamber, West Side: 1 specimen 88 mm. long.

Two specimens, 46 and 55 mm. long, were taken in Miraflores Lake. It was not seen in the Pedro Miguel Locks.

***Anchovia rastralis*** (Gilbert & Pierson).

Upper Chamber, West Side: 5 specimens, 53 to 55 mm. long.

Lower Chamber, West Side: Many present; 40 specimens, 57 to 105 mm. long, were preserved.

Lower Chamber, East Side: A single specimen 63 mm. long.

***Lycengraulis poeyi*** (Kner & Steindachner).

Upper Chamber, West Side: 3 specimens, 140, 160 and 185 mm. long.

***Cetengraulis mysticetus*** (Günther).

Upper Chamber, West Side: 1 specimen 53 mm. long.

Lower Chamber, West Side: Numerous; 41 specimens, 53 to 90 mm. long, were preserved.

## FAMILY POECILIIDAE. TOP MINNOWS.

***Poeciliopsis elongatus*** (Günther).

Upper Chamber, West Side: 11 specimens, 19 to 38 mm. long.

Lower Chamber, West Side: 54 specimens, 26 to 47 mm. long.

Upper Chamber, East Side: 2 specimens, 56 and 60 mm. long.

This brackish water minnow was numerous in both chambers of the west side, where many either were stranded or occupied the "manholes" in the floor of the locks.

## FAMILY HEMIRHAMPHIDAE. HALFBEAKS.

***Hyporhamphus snyderi*** Meek & Hildebrand.

Lower Chamber, East Side: 2 specimens, 143 and 175 mm. long.

## FAMILY ATHERINIDAE. SILVERSIDES.

***Menidia (Thyrina) chagresi*** Meek & Hildebrand.

Lower Chamber, West Side: 3 specimens, 25, 27 and 88 mm. long.

This Atlantic slope fish, confined to fresh and brackish water, was taken also in the Pedro Miguel Locks.

***Kirtlandia gilberti*** (Jordan & Bollman).

Lower Chamber, East Side: 2 specimens, 38 and 117 mm. long.

East side: 3 specimens, 36, 48 and 120 mm. long.

## FAMILY MUGILIDAE. MULLETS.

***Mugil curema*** Cuvier & Valenciennes.

Lower Chamber, West Side: 9 juveniles of one school, 46 to 56 mm. long, and 14 of another school, 24 to 33 mm. long, were preserved.

Upper Chamber, East Side: 3 specimens, 30, 38 and 45 mm. long.

East side: 1 adult 235 mm. long.

Juveniles were taken, also, in Miraflores Lake and Pedro Miguel Locks.

## FAMILY POLYNAEMIDAE. THREADFINS.

***Polynemus approximans*** Lay & Bennett.

Lower Chamber, East Side: 1 juvenile 29 mm. long.

East Side: 2 adults, 195 and 205 mm. long.

## FAMILY CARANGIDAE. CREVALLE, JACKS, POMPANOS, ETC.

**Caranx hippos** (Linnaeus). "Jack."

Upper Chamber, West Side: 1 specimen 135 mm. long.

Lower Chamber, West Side: 8 specimens, 105 to 125 mm. long.

East Side: 1 large individual 610 mm. long.

This species as here understood occurs on both coasts of Panama. Though some writers have attempted to separate the specimens from the opposite coasts, giving the name *C. caninus* to the Pacific coast one, I am not convinced that the supposed differences are well founded.

The scarcity of this species in the Miraflores Locks contrasts sharply with its abundance in the Gatun Locks. It is not known to invade strictly fresh water.

**Caranx marginatus** (Gill).

Upper Chamber, West Side: A single specimen 140 mm. long.

**Oligoplites mundus** Jordan & Starks. Leather jack.

East Side: 1 specimen 365 mm. long.

**Oligoplites saurus** (Bloch & Schneider). Leather jack.

Lower Chamber, West Side: 3 specimens, 29, 38 and 62 mm. long.

East Side: 2 specimens, 190 and 205 mm. long.

This species, which is common to both coasts of Panama, was not seen in the Gatun Locks, and is not known to enter fresh water.

**Trachinotus kennedyi** Steindachner. Pompano.

East Side: 1 large individual 645 mm. long.

**Chloroscombrus orqueta** Jordan & Gilbert.

Lower Chamber, West Side: 1 specimen, a juvenile 54 mm. long.

East Side: 8 specimens; one juvenile 40 mm. long, and 7 adults 185 to 205 mm. long.

**Selene brevoortii** (Gill). Moonfish.

Lower Chamber, East Side: 1 juvenile 70 mm. long, and an adult 265 mm. long.

**Vomer declivifrons** Meek & Hildebrand. Moonfish; horsefish.

Lowest Chamber, West Side: 1 specimen 335 mm. long.

East Side: 1 individual 250 mm. long.

## FAMILY APOGONIDAE. CARDINAL-FISHES.

**Apogon dovii** Günther.

Lower Chamber, West Side: 1 specimen 100 mm. long.

## FAMILY CENTROPOMIDAE. ROBALOS; SNOOK.

**Centropomus pectinatus** Poey.

This species, which is known from both coasts of tropical America, was not seen in Miraflores Locks. However, 2 specimens, 95 and 330 mm. long, were taken in Miraflores Lake. The fish presumably had to pass through the Miraflores Locks to reach this lake. It was not taken in the Gatun Locks.



***Centropomus unionensis* Bocourt.**

Upper Chamber, West Side: 3 specimens, 110, 160 and 200 mm. long.

Lower Chamber, West Side: 2 specimens, 115 and 170 mm. long.

***Centropomus nigrescens* Günther.**

Lower Chamber, West Side: 1 individual about 450 mm. long, quite certainly of this species, was laid aside, but disappeared by the "route of the fish-hungry."

In addition 2 small specimens, 55 and 95 mm. long, were taken in Miraflores Lake, presumably having passed through Miraflores Locks to reach that lake.

FAMILY SERRANIDAE. SEA BASSES, GROUPERS, JEWFISH, ETC.

***Epinephelus labriformis* (Jenyns). Grouper.**

Upper Chamber, West Side: 5 specimens, 38 to 180 mm. long.

***Promicrops itaiara* (Lichtenstein). Jewfish.**

Upper Chamber, West Side: 1 specimen about a foot long was seen, but disappeared, having been taken by someone who was hungry for fish.

Lower Chamber, East Side: 1 individual 975 mm. (39 inches) long, weighing 47 pounds, was present. Only the head and tail were preserved.

***Rypticus saponaceus bicolor* (Valenciennes). Soapfish.**

Lower Chamber, West Side: 19 specimens, 61 to 155 mm. long, were preserved. Many more were present in the sumps and bottom slush.

East Side: 2 specimens, 86 and 121 mm. long.

The identification is by Dr. L. P. Schultz of the U. S. National Museum, who regards the Pacific Coast specimens as only subspecifically distinct from the Atlantic ones. The two nominal species listed in our earlier work (1925, pp. 481 and 482), *R. xanti* Gill and *R. nigripinnis* Gill, are regarded as synonyms of the above name.

FAMILY LUTIANIDAE. SNAPPERS.

***Lutianus novemfasciatus* Gill.**

Lower Chamber, West Side: 1 specimen, 395 mm. long, was preserved. Only a few others were seen.

This species was taken also in the Pedro Miguel Locks.

***Lutianus colorado* Jordan & Gilbert.**

Lower Chamber, West Side: 1 specimen, 410 mm. long, was measured and critically examined. Many more were present, mostly quite large. Probably about 50 pounds of this species and *L. argentiventris* were removed from this flight by Canal employees.

East Side: 1 specimen, 150 mm. long, was preserved. According to Dr. Foster this fish was numerous in the east side of the locks.

Although this snapper was not taken in the upper chamber (west side) of the locks, specimens were secured in Pedro Miguel Locks and Miraflores Lake, where it appears to be common. Though this snapper tolerates virtually fresh water, it is not known to have advanced beyond the Pedro Miguel Locks.

***Lutianus argentiventris* (Peters).**

Upper Chamber, West Side: 2 specimens, 65 and 353 mm. long, were preserved. Several others were seen.

Lower Chamber, West Side: 13 specimens, 90 to 230 mm. long, were preserved. Many present. Probably about 50 pounds of this species and of *L. colorado* were removed from this flight by Canal employees.

East Side: 3 specimens, 90, 160 and 270 mm. long, were preserved. It was common in the east side of the locks, according to Dr. Foster.

FAMILY HAEMULIDAE. GRUNTS.

***Orthopristis chalceus*** (Günther).

East Side: 5 specimens, 170 to 225 mm. long.

***Pomadasys leuciscus*** (Günther).

East Side: 2 specimens, 370 and 385 mm. long.

This is *Brachydeuterus nitidus* of Jordan & Evermann (*Bull. U. S. Nat. Mus.* XLVII, 1898, p. 1326) and others, which merges with *P. leuciscus* according to our earlier studies (1925, p. 451).

***Anisotremus pacifici*** (Günther).

Upper Chamber, West Side: 3 specimens, 200, 280 and 320 mm. long, were preserved. Many more were present. Ten were dissected and were found to be 8 females and 2 males, all nearly ripe.

Lower Chamber, West Side: 1 specimen, 315 mm. long, was preserved. This species was nearly as numerous in this flight as in the upper one. Six specimens were examined for spawning condition; only 2 had large roe.

***Anisotremus dovii*** (Günther).

Lower Chamber, West Side: A single small specimen, 55 mm. long, was doubtfully identified as this species.

East Side: 1 specimen 200 mm. long.

FAMILY GERRIDAE. MOJARRA (MARINE).

***Eucinostomus californiensis*** (Gill).

Upper Chamber, West Side: 2 specimens, 42 and 60 mm. long.

Lower Chamber, West Side: 13 specimens, 47 to 82 mm. long.

East Side: Two specimens, 62 and 78 mm. long.

One specimen, 145 mm. long, was taken in Miraflores Lake. To reach this lake the fish presumably had to pass through Miraflores Locks.

***Gerres cinereus*** (Walbaum).

Upper Chamber, West Side: 3 specimens, 56, 59 and 68 mm. long.

Lower Chamber, West Side: 1 specimen 55 mm. long.

One large specimen, 370, mm. long, was taken in Miraflores Lake, presumably having passed through the locks to reach this lake.

This species inhabits both coasts of tropical America. Although it evidently has much tolerance for fresh water it does not seem to have advanced in the Canal beyond Miraflores Lake on the Pacific side. It was not seen in Gatun Locks.

***Diapterus peruvianus*** (Cuvier & Valenciennes).

Lower Chamber, West Side: 15 specimens, 23 to 110 mm. long (mostly juveniles).

Lower Chamber, East Side: 6 specimens, 70 to 145 mm. long.

Eight specimens of this species, ranging in length from 50 to 285 mm., were taken in Miraflores Lake. It is probable that the fish passed through Miraflores Locks to reach this lake.

***Diapterus axillaris*** (Günther).

Upper Chamber, West Side: A single specimen, 247 mm. long, seems to belong to this species, which previously was not reported from Panama.

## FAMILY KYPHOSIDAE. RUDDER-FISHES.

***Kyphosus elegans*** (Peters).

East Side: 1 specimen 410 mm. long.

## FAMILY SCIAENIDAE. CROAKERS, SEA TROUT, DRUMS, ETC.

***Micropogon altipinnis*** Günther.

Upper Chamber, West Side: 3 specimens, 72, 103 and 180 mm. long.

Lower Chamber, West Side: 13 specimens, 52 to 152 mm. long; and 69 juveniles, 12 to 40 mm. long, which probably also belong to this species.

East Side: 2 specimens, 135 and 182 mm. long.

The young of this species seem to be common in Miraflores Lake where 18 specimens, 40 to 125 mm. long, were taken.

***Stellifer oscitans*** (Jordan & Gilbert).

Lower Chamber, West Side: 1 specimen 103 mm. long.

***Stellifer illecebrosus*** Gilbert.

Lower Chamber, West Side: 4 small specimens, 67 to 80 mm. long; and 3 juveniles, 22, 33 and 35 mm. long, which may belong to this species.

***Bairdiella ensifera*** (Jordan & Gilbert).

Upper Chamber, West Side: 2 specimens, 78 and 130 mm. long.

Lower Chamber, West Side: 3 specimens, 85, 120 and 150 mm. long.

***Ophioscion typicus*** Gill.

Upper Chamber, West Side: 3 specimens, 175, 180 and 185 mm. long.

Lower Chamber, West Side: 1 specimen 168 mm. long.

East Side: 2 specimens, 183 and 200 mm. long.

***Ophioscion scierus*** (Jordan & Gilbert).

Lower Chamber, West Side: 1 small specimen, 89 mm. long, doubtfully identified as this species.

***Cynoscion albus*** (Günther). "Yellow corbina."

Upper Chamber, West Side: 5 specimens, 235 to 265 mm. long.

Lower Chamber, West Side: 2 specimens, 240 and 310 mm. long, were preserved. Some fairly large ones, measuring up to 30 inches in length, were present.

Although no specimens were preserved, this species was numerous in the east side of the locks, according to Dr. Foster.

Small individuals were taken also in Pedro Miguel Locks, showing that this species has much tolerance for fresh water.

The "yellow corbina" is a highly prized foodfish in Panama. A length of about 40 inches and a weight of 25 pounds are not unusual. It is sought extensively by sportsmen.

***Larimus effulgens*** Gilbert.

East Side: 1 specimen 280 mm. long.

## FAMILY EPHIPPIDAE. SPADE-FISHES.

**Chaetodepterus zonatus** (Girard).

East Side: 3 specimens, 220, 220, and 235 mm. in length.

## FAMILY CICHLIDAE. MOJARRAS DE RIO.

**Cichlasoma maculicauda** Regan.

Upper Chamber, West Side: 3 specimens, 32, 70 and 85 mm. long.

This Atlantic slope fish was taken also in Miraflores Lake and in Pedro Miguel Locks.

## FAMILY TETRAODONTIDAE. PUFFERS.

**Sphoeroides annulatus** (Jenyns).

Lower Chamber, West Side: 1 specimen 225 mm. long.

East Side: 1 specimen 195 mm. long.

**Sphoeroides fürthii** (Steindachner).

Lower Chamber, West Side: 1 juvenile 28 mm. long.

**Guentheridia formosa** (Günther).

East Side: 1 specimen 225 mm. long.

## FAMILY GOBIIDAE. GOBIES; GUAVINAS.

Small gobies, principally naked ones, were very common in both chambers of the west side in the slush, where an inch or two of water remained on the floor after pumping had ceased. Although the different species were not recognized in the field, their relative abundance is believed to be shown more or less by the number of specimens collected of each species.

**Dormitator maculatus** (Bloch).

Lower Chamber, East Side: 15 small specimens, 20 to 85 mm. long, seem to be of this Atlantic slope species.

**Dormitator latifrons** (Richardson).

This species was not seen in the locks when they were dewatered, but later, after the locks had been refilled (Sept. 30, 1937), Mr. C. B. Lear took several fine specimens which were in spawning condition.

**Eleotris picta** Kner & Steindachner.

Upper Chamber, West Side: 5 specimens, 43 to 80 mm. long.

Lower Chamber, East Side: 2 specimens, 20 and 245 mm. long.

This fish is common in Miraflores Lake, and it was numerous in Pedro Miguel Locks. Some evidence of cross breeding with its near relative, *pisonus*, of the Atlantic slope was found (see under this species in the list for Pedro Miguel Locks).

**Leptophilypinus fluviatilis** Meek & Hildebrand.

Upper Chamber, West Side: 16 specimens, 28 to 48 mm. long, were captured. Others were seen in the "manholes" in the floor of this flight. It was not found in the lower chamber.

This Atlantic slope fish was taken also in Pedro Miguel Locks and in the Gatun Locks.

***Erotelis clarki*** (Hildebrand).

Lower Chamber, West Side: 5 specimens, 77 to 150 mm. long, including the type of this species.

Upper Chamber, East Side: 2 specimens, 70 and 115 mm. long.

East Side (level unknown): 4 specimens, 80 to 150 mm. long.

This species recently described by me (*Field Mus. Nat. Hist. Pub., Zool. Ser.*, XXII, 1938, p. 352) has not been taken elsewhere.

***Bathygobius soporator*** (Cuvier & Valenciennes).

Lower Chamber, West Side: 4 specimens, 69 to 86 mm. long. Others were present, but the species was not numerous.

Upper Chamber, West Side: 2 specimens, each 84 mm. long.

***Enypinas aceras*** Ginsburg.

Lower Chamber, West Side: 8 specimens, 24 to 46 mm. long, type material.

***Enypinas seminudus*** (Günther).

Upper Chamber, West Side: 6 specimens, 23 to 45 mm. long.

Lower Chamber, West Side: 95 specimens, 16 to 51 mm. long.

Upper Chamber, East Side: 12 specimens, 36 to 57 mm. long.

Lower Chamber, East Side: 6 specimens, 36 to 53 mm. long.

***Gobionellus liolepis*** (Meek & Hildebrand).

Upper Chamber, East Side: 1 specimen 31 mm. long.

***Gobionellus manglicola*** (Jordan & Starks).

Upper Chamber, West Side: 6 specimens, 27 to 32 mm. long.

Lower Chamber, West Side: 28 specimens, 18 to 32 mm. long.

Upper Chamber, East Side: 16 specimens, 21 to 40 mm. long.

***Gobionellus sagittula*** (Günther).

Lower Chamber, West Side: 1 specimen 38 mm. long.

***Garmania paradoxa*** (Günther).

Lower Chamber, West Side: 33 specimens, 19 to 35 mm. long.

Lower Chamber, East Side: 2 specimens, 25 to 35 mm. long.

***Gobioides peruanus*** (Steindachner).

Lower Chamber, West Side: 1 specimen 248 mm. long. This goby was seined on deep mud in the sump next to the "seagates" of the locks. It was thought to be a snake by my helper, who warned me to keep hands off. A new record for Panama.

***Gobiosoma nudum*** (Meek & Hildebrand).

Lower Chamber, West Side: 1 specimen 27 mm. long.

***Microgobius tabogensis*** Meek & Hildebrand.

Upper Chamber, West Side: 1 specimen 30 mm. long.

Lower Chamber, West Side: 28 specimens, 22 to 50 mm. long.

***Microgobius emblematicus*** (Jordan & Gilbert).

Lower Chamber, West Side: 1 specimen 44 mm. long.

***Parrella spilopteryx*** Ginsburg.

Upper Chamber, East Side: 1 specimen, 74 mm. long, the type.

**Parrella fusca** Ginsburg.

Lower Chamber, West Side: 1 specimen, 42 mm. long, the type.

## FAMILY BATRACHOIDAE. TOADFISHES.

**Batrachoides pacifici** (Günther).

Lower Chamber, West Side: 5 specimens, 32 to 290 mm. long.

**Porichthys greenei** Gilbert & Starks.

Lower Chamber, West Side: 2 specimens, each 87 mm. long.

**Porichthys margaritatus** (Richardson).

East Side: 1 specimen 177 mm. long.

This species previously was not taken in shallow water in the vicinity of the Canal Zone. The determination is by Dr. L. P. Schultz.

**Thalassophryne reticulata** Günther.

Lower Chamber, West Side: Saw one badly decomposed specimen, about 150 mm. long, floating in a sump a few days after the main body of water had been removed. The specimen certainly was of this genus, though there is doubt as to whether it was *reticulata* or *dowii*.

## FAMILY BLENNIIDAE. BLENNIES.

**Hypsoblennius** sp.

Lower Chamber, West Side: 17 specimens, 16 to 70 mm. long.

The specimens are near *H. lignus*, but differ in minor structures, requiring further study.

## FAMILY SOLEIDAE. SOLES.

Small soles were fairly common in the bottom "manholes," but were rather difficult to catch.

**Achirus fimbriatus** (Günther).

Upper Chamber, West Side: 17 specimens, 15 to 40 mm. long.

Lower Chamber, West Side: 5 specimens, 24 to 50 mm. long.

Lower Chamber, East Side: 2 specimens, 35 to 40 mm. long.

**Achirus fluviatilis** Meek & Hildebrand.

Lower Chamber, West Side: 1 specimen 50 mm. long.

This sole was taken also in the Pedro Miguel Locks.

**Achirus klunzingeri** (Steindachner).

Upper Chamber, West Side: 1 specimen 71 mm. long.

Lower Chamber, West Side: 3 specimens, 58, 62 and 63 mm. long.

Upper Chamber, East Side: 2 specimens, 70 and 95 mm. long.

**Symphurus elongatus** (Günther). Tongue fish.

Upper Chamber, West Side: 14 specimens, 20 to 64 mm. long.

Lower Chamber, West Side: 28 specimens, 17 to 80 mm. long.

Upper Chamber, East Side: 2 specimens, 43 and 65 mm. long.

Lower Chamber, East Side: 3 specimens, 51, 58 and 75 mm. long.

EXPLANATION OF THE PLATES

PLATE I.

- Fig. 1. Gatun Locks, Panama Canal, looking toward Gatun Lake, showing vessels in transit. Courtesy Panama Canal.
- Fig. 2. Scene in base of dewatered Gatun Locks, showing stranded fish, consisting mostly of "jacks," *Caranx hippos*.

PLATE II.

- Fig. 3. Wall of upper chamber of dewatered lock, showing growth of bivalve mollusc, *Congria (Mytilopsis) sallei*; also the "skiff" operated by a crane, lowering collectors into the lock.
- Fig. 4. Lifting collecting seine after a haul in the sump of Pedro Miguel Locks.